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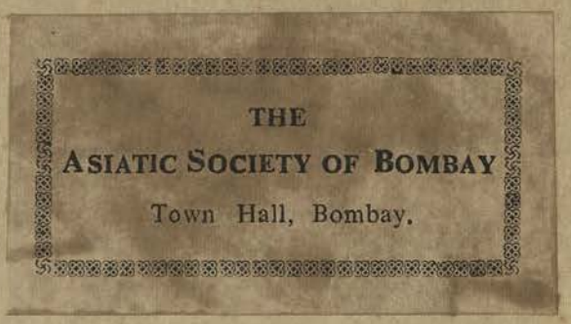

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THE

INFLUENCE OF MATERIAL

ON

ARCHITECTURE.

64227

BY

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PREFACE.

THE "Influence of Material on Architecture" being the subject given by the Council of the Royal Institute of British Architects for the Essay Medal for 1896, the following Essay was submitted and obtained the Medal. It was then printed in the "Builder," and at the request of many friends is now published in book form along with the Illustrations. It must be remembered that it is an Essay, necessarily short by the rules of the Council, and was kept strictly within well-defined limits of space, so that many interesting by-paths have not been entered. It is, however, a subject of considerable importance and great fascination for Architects, and should appeal to an even wider circle. A limited edition has, therefore, been printed, and it is hoped will prove of interest to those who may be led to read it.

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LUDGATE CIRCUS, E.C.,
Michaelmas, 1897.

THE INFLUENCE OF MATERIAL ON ARCHITECTURE.

BY BANISTER F. FLETCHER, A.R.I.B.A.

Architecture is an affair of material, the true use or needs of which mould the style, which is created out of the qualities of the materials that have to be employed.

INTRODUCTION.

MATERIALS are the media in which architecture is expressed; they are at once the rulers and the slaves of the most abstract of the arts. Architectural idealism has to be embodied in the shapes created from inanimate Nature around us. Thus it is that, at one time, materials by their solid reality oppress the imagination, as amidst the close-set columns of an Egyptian hall; while at another the successful expression of the abstract triumphs beneath the magic circle of some Byzantine dome—hanging as by a chain from Heaven—or within some airy Gothic structure where matter seems spiritualised to a film of gossamer.

Thus the influence of materials on architecture is undoubted; for even when style is paramount we have but a proof of the vitality of the principle. Style is created by the discoveries of experience or genius out of the qualities of the materials employed. Successive periods have had their distinctive materials, of which they seem to have exhausted the possibilities, and their resulting methods of treatment are the basis of what is afterwards classified as "style." Changes of style are forced on by the use of new materials, to which at first the old forms are applied. After a period the old forces of tradition and prejudice are laid aside, and the new forces of utility, reason, and cost draw attention to the innate qualities of the newer materials, which, finding expression, develop to a greater or less degree of perfection a new style.

The philosophy of the argument stated is that architecture is an affair of material, the true use or needs of which mould the style, and that style is created out of the qualities of the material that has to be employed. In following up this axiom, the Egyptian style will be traced, changing from a mud architecture to one of stone and granite; West Asiatic architecture, starting from mud types, developed through brickwork; the Grecian, from an Archaic or early wooden type, changing in the best periods to marble; and the true architecture of Rome seen to be brickwork and concrete, a development which was continued in the Byzantine style.

The Romanesque period is one of destruction, of the re-use of classic materials emerging after a troublous period into the Gothic style—essentially one of stone.

The Renaissance period, again, is a period of relapse—one where materials no longer forming the style, the same design is found executed in very varied materials.

In the modern period the stream of architectural development has, as it were, flowed beneath the surface in the artistically unrecognised use of iron and steel with their compounds. In tracing the influence of these great materials, it must be observed that during this period the building art has been divided by the purely constructive side disengaging itself, under the name of engineering, and thus robbing architecture of one of her most powerful incentives towards progress.

Architecture proceeds from structure, and the first condition at which it should aim is to make the outward form accord with that structure. Many constructive features offer to us a manifestation of the tendency, always existing, which consisted in transforming into a decorative feature that which previously was only a practical need. In all styles certain combinations went gradually from the domain of the art of building, to pass into that of decoration, and thus the spirit of architecture was modified insensibly.

Within the limits of an essay it is impossible to do more than trace the main stream of the great historical styles, and it is equally necessary to exclude the rival moulding forces that may be classed together in the term civilisation, not because their influence is unrecognised, but in order that the influence under consideration—the influence of material—may be fairly brought out.

Dealing with details, it will be seen that the use of plaster, glass, and mosaic has had some influence, but, perhaps, scarcely sufficient to form styles of themselves, although it would be difficult to discuss the Byzantine or Gothic periods without detailed reference to mosaic or glass respectively.

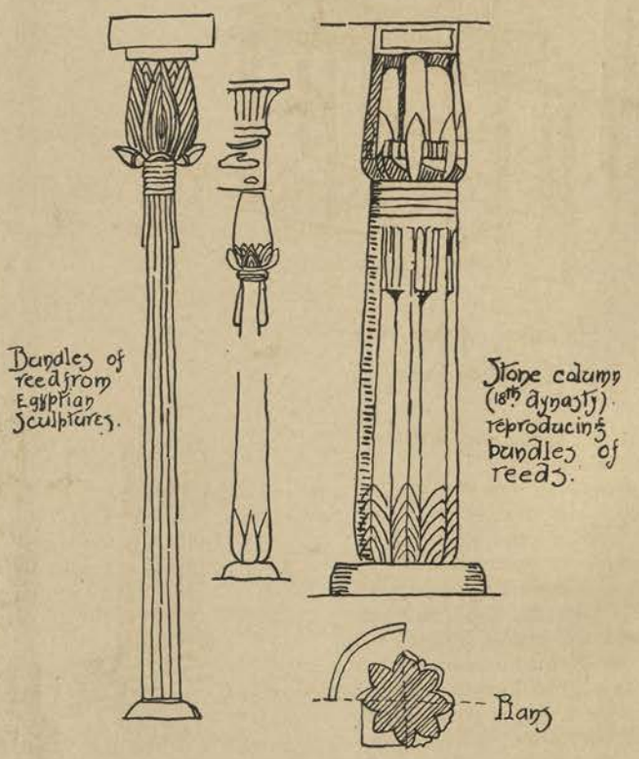
CHAPTER I.

EGYPT: MUD AND REEDS TO GRANITE.

IN the valley of the Nile, the land which is the gift of a great river, and the seat of the most ancient civilisation, a primitive architecture of mud or puddled clay and bundles of reeds is discovered, changing in later times to a style of stone and granite.

The primitive structure was composed of bundles of reeds bound together and placed at intervals vertically in the ground, the angle bundles being strengthened. On these reeds, and joining them at the top, were laid horizontally other bundles, which bound the heads of the uprights together. The origin of the characteristic cornice is held to be due to the pressure of the clay (of which the primitive roofs were constructed) on the upright reeds, which formed the framework of the walls. These reeds were held in position by being bound to the horizontal roll resting on the top of the columns. This formed the slightly projecting cornice, the reeds keeping the rammed clay in a projecting position and allowing the curve to be terminated by a flat fillet which gave the level of the terrace. The jambs and lintels of the doors and windows were made of reeds in the humbler dwellings and of palm trunks in those of more pretension.

Here, then, is seen a fair and likely prototype of the construction of an Egyptian wall, the forms of which are more suitable to a structure of rushes overlaid with mud or puddled clay than to one consisting of large stones. Still, an important point remains—the batter or slope which is invariably given to the walls. Viollet-le-Duc's theories as to the origin of this batter scarcely point to the influence of material, and this feature is alleged by him to have been introduced at a later stage, having been promulgated by a royal decree. He infers the custom to have been derived from the pyramids, which were found to remain undisturbed during earthquakes, while straight-sided houses were upset, owing to the centre of gravity being placed outside the wall. It seems, however, more reasonable to attribute it to a mud origin, for nothing would be more natural, in order to strengthen such buildings, than to slightly tilt the bundles of reeds towards the interior, forming as it were an arch, a treatment which in any other material scarcely seems to be feasible.



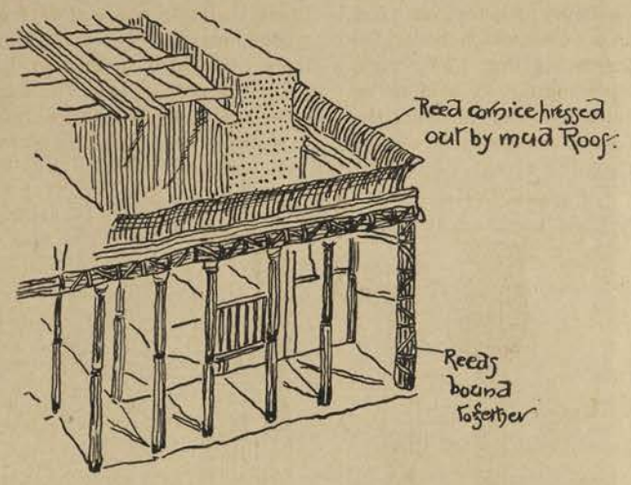
Derivation of Egyptian Column from Reeds bound together.

Proceeding to the internal architectural features of the style, a very distinct recollection of the primitive reeds tied together at intervals, and crowned with the lotus bud, is found in the later granite column and capital. During the Theban kingdom especially (B.C. 5000—B.C. 2300) examples in stone of capitals and columns derived from timber and reed originals are frequent. At Beni-Hassan the pillars represent a bundle of four reeds or lotus stalks bound together near the top and bulging above the ligature, in imitation of a lotus bud, so as to form a capital. Such a pier must evidently have been originally employed in wooden architecture only,

and the roof which it supports, in this instance, represents a light wooden construction having the slight slope necessary in the dry Egyptian climate.

This type of column was largely used in later Egyptian times in a more substantial lithic form, and in conjunction with the hollow-formed capital of the bell type, of which the earliest example appeared in the eighteenth dynasty.

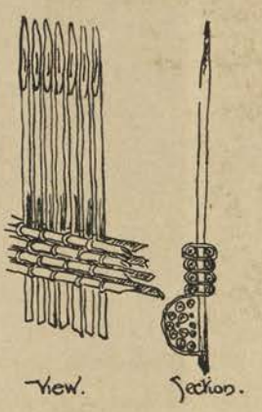
In fact, throughout, although materials changed, the forms of the early reed and clay construction were adhered to; and the endeavour of the conservative Egyptian was to reproduce in stone and granite superimposed in layers the appearance assumed in the early reed and mud type.



Buildings of primitive Egyptian House.

The surface decoration executed on the later granite buildings apparently came from the "sgraffito" work on the earlier mud walls. The surfaces of such walls could not be modelled or carved with projections of high relief, but their flat surfaces, when plastered, provided an admirable field for decoration and for instruction through the use of hieroglyphics. The Egyptian system of decoration consisted in not contravening the form adopted, but clothing it with a kind of drapery more or less rich, which never presented a projecting outline, but contented itself with enveloping the geometric form as would an embroidered stuff, or a diapered covering.

Remarkable then as are the arts of Egypt, it is clear, that in so far as material is concerned, the spirit of criticism and logical method is wanting; and that traditional forms, hallowed by long use, were clung to and reproduced when the method of building which suggested them had been replaced by other systems. Egyptian art proceeds on an uninterrupted line or course of tradition, and when necessity dictates a change in the methods of construction, or in the materials, the immutable form is not thereby affected, but is perpetuated in spite of novel conditions. With the Egyptians the influence of materials, though evident and important, has not the radical and progressive force that has characterised the development of architecture with the more vigorous races of the west.



Structure of Reeds.

CHAPTER II.

ASSYRIA: MUD TO BRICK OR WOOD TO STONE.

THE banks of the Tigris and Euphrates present only alluvial plains, where wood suitable for building is rare. The country, however, possesses an abundance of clay, which, being thrown into flat square moulds, beaten and compressed, and dried in the sun, gives a material which lends itself readily to a treatment consistent with its qualities. Of such a material were formed the huge platforms upon which temples and palaces were built. These immense platforms were faced with sun-dried bricks, and subsequently with kiln-burnt bricks, or in the later Assyrian period with stone slabs from the mountains that separate Assyria from Media. Here will be perceived how the salient characteristics of the architecture may be explained by the nature of the materials at hand, for the walls being of brick, each unit, in general, is a repetition of its neighbour, and rarely of special shapes. The buildings composed of them could only be decorated by attached ornament, similar in principle to the mats and hangings we spread over the floors and walls we wish to hide.

The arch now first appears on the architectural horizon as applied to openings. In some cases it is not a true arch, but one formed by corbelling or projecting horizontal courses; but, finally, the true arch was practised, being probably accidentally hit upon by the use of small units of materials, which must have had a direct influence, for the Chaldæans were unable to support the upper part of their walls, ceilings, or roofs upon beams of stone or timber, owing to the lack of these in suitable forms, and they had to devise some other means of arriving at the desired results. It is a general law, which study and comparison will confirm, that the arch was soonest discovered and most invariably employed by those builders who found themselves condemned by the geological formation of their country to the employment of the smallest units.

These arches, in the absence of piers, rested on thick and solid walls; and whether in the piercing of immense mounds by vaulted drains, or as prominently placed in the most careful and elaborate façades, the arch, forming an imposing entrance, and accentuated by a brilliantly coloured soffit, held a place of extreme importance.

In Chaldea, isolated supports, such as are found in the hypostyle halls of Egypt and Persia, or in the naves of Greek temples and Latin basilicas, were untenable; the want of suitable stone put any such arrangement out of the question. The Chaldæans and Assyrians never used stone constructively except as the envelope for a brick wall. The pillars, roofs, and constructive features of their buildings were of wood, however; but in the Persian period after the conquest of Egypt by Cambyses in about 530 B.C., Asiatic nations for the first time employed stone for pillars. The Persians especially used the material (stone) which was found in abundance in the neighbourhood of their capitals; in the rocky country of Persia, at Susa and Persepolis, only the bones of their buildings remain, the enclosing walls of brick having disappeared. It is to be remarked how these Persepolitan halls show the influence of the Assyrian wooden style in having closely spaced columns, which, although necessary in the halls of the Assyrian prototype, were not so when the columns were executed in stone and supported a light wooden roof.

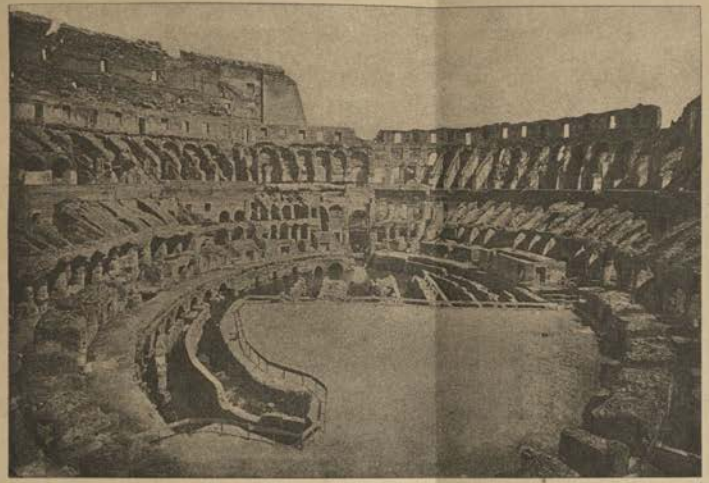
The bracket and scroll capitals of the columns at Persepolis and Susa retain much of the form of their wooden prototype, and demonstrate very clearly that a form which, applied to wood, is natural and inoffensive, becomes clumsy and inappropriate when applied to stone.

In regard to architectural character, Texier's description of the great mosque at Ispahan (1587-1629) might, it is believed, be applied with general accuracy to the principal buildings of ancient Babylon, if the power of a Merlin could bring them back to our view: "Every part of the building, without exception, is covered with enamelled bricks. Their ground is blue, upon which elegant flowers and sentences taken from the Koran are traced in white. The cupola is blue decorated with shields and arabesques. One can hardly imagine the effect produced by such a building on an European accustomed to the dull uniformity of our colourless buildings."* The principal difference between this and those of ancient Babylon would be that arising out of the prohibitions of the Koran, for we find that in the latter period the Assyrians either cased their walls with limestone and alabaster (an expensive and laborious system), especially in Chaldæa, where stone was too costly (in consequence of the distance it had to be carried), or faced them with a skin of glazed and coloured brickwork of many colours.

Sculpture was confined to the lower part of the walls, and placed on limestone or alabaster slabs; in the upper part the problem was solved in a similar fashion by the extensive use of enamelled brick and painted stucco, and the elaboration of a rich, elegant, and withal original system of polychrome.

At Nineveh stucco appears to have been formed by the mixing of burnt chalk with plaster, which gave a sort of white gum that adhered tightly to the clay wall. At Khorsabad an ornamentation of portions of cylinders, in juxtaposition like trunks of trees placed vertically together, was employed externally. This style of decoration is a last reminiscence, as it were, of the timber stockading which had originally served to keep up and preserve the tempered earth before the regular use of sun-dried bricks.

Before leaving Asia, it will be well to



Roman Architecture : interior of the Coliseum.

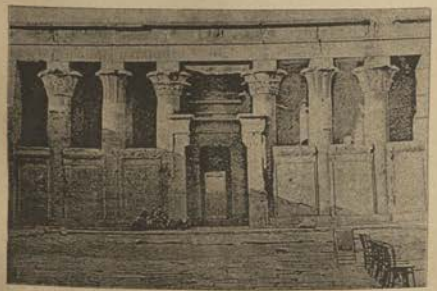
Roman Architecture : the Amphitheatre, Verona.

Egyptian Walls : Reminiscence of the Mud type.

Tomb at Beni-Hassan : Reminiscence of Timber entablature.

Greek Marble Sculpture.

Assyrian Sculpture : monolithic man-headed lion.



Temple at Edfou : Early Reed and Lotus Capitals translated into granite.

Egyptian Sphinx : a granite monolith.

Assyrian Sculpture : continuous wall treatment in alabaster slabs.

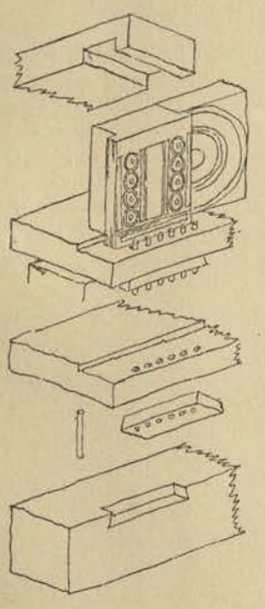
glance for a moment at the district known as Asia Minor, and note how many of the buildings present stone forms borrowed from a timber type. The influence of tradition there is manifest, and the Tombs of Lycia present this feature more strongly perhaps than any remains in Western Asia. In one example from the British Museum, above a double podium, probably even originally of stone, is placed a rectangular chest, or sarcophagus, certainly copied from a wooden form, all the mortices and framing, even to the pins that held them together, being literally rendered in the stone-work. Above is a curvilinear roof of pointed form, which also is a copy of an original in wood. In Lycia other rock-cut tombs present flat and sloping roofs, in which unhewn timbers are literally copied; and the last stage shows us an Ionic façade developed from these carpentry forms.

Copying of timber forms in stone can also be traced in Egypt; in Central Asia by the Persians; in India, where it was introduced by the Bactrian Greeks, between the second and third century B.C., and in Greece somewhat earlier than in Lycia, say in the seventh century B.C. Thus it will be seen that style created by one material does not long survive its disuse. It was only in the infancy of stone architecture that men adhered to wooden forms; as soon as habit gave them familiarity with the new material, they abandoned the incongruities of the wooden style, and all trace of the original form passed away.

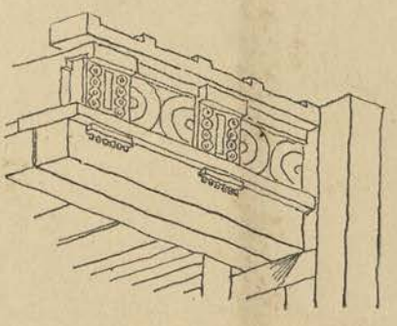
CHAPTER III.

GREECE: TIMBER TO STONE AND MARBLE.

MUCH as Greek culture owed to the preceding Asiatic civilisation, still the change effected through them in its nature and tendencies has so profoundly affected the development of European progress, as to constitute the Greeks the veritable source of literary and artistic inspiration. Greek architecture stands alone in being accepted as beyond criticism, and as being an obligatory study for students of otherwise very different principles. What was the real course of the development of this great style, and more especially what was its origin, and how did the influence of materials affect it?



Pieces of Architrave and Frieze in Mycenæan Palace.



Component parts put together.

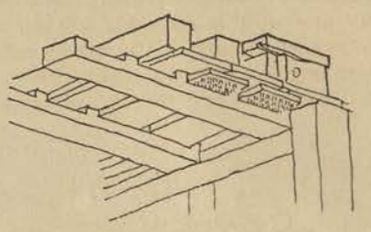
Perrot and Chipiez' Theory of Greek Doric Entablature.

Perrot and Chipiez, in their monumental work on "Art in Primitive Greece," go elaborately into the question of the wooden origin of the Greek column and its entablature, and endeavour to show how the timber construction of the period was imitated in the maturer style in stone. Some sketches are given from their illustrations. In the origin of the Doric order there are some interesting suggestions, particularly the derivation of the guttæ from constructive pegs. And it may be allowed that the restoration given of the timber architecture of the palaces of this period, and the explanation of the wooden types used decoratively in the later stone architecture, are well dovetailed into each other. The authors decline to accept the favourite theory of the derivation of the Doric capital from the Egyptian—as, for instance, the Doric capital at Beni-Hassan—but give no derivation of it themselves.

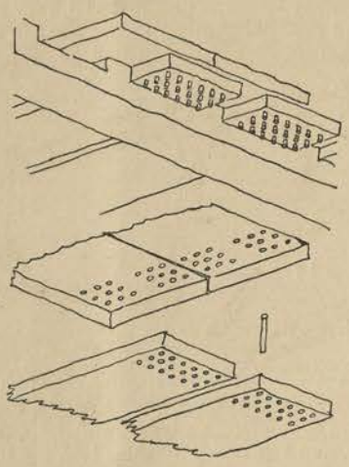
Viollet-le-Duc, however, refutes the wooden origin of Greek architecture, and holds that it is emphatically an original stone treatment. He is unable to conceive how the Greek Doric capital can be derived from a timber form, and he considers the triglyphs in the

frieze, instead of being derived from the ends of wooden beams—which could not be seen on four sides of a building, and which would be very difficult to flute across the grain of the wood—to be original stone uprights, fluted to express their function of vertical support, and therefore treated in this respect in the same manner as the columns, which he considers were fluted when in position. But Garbett calls the wooden theory an "insolent libel," and asserts that in the case of the inclination of the soffit, this barbarous theory is at once disproved by two facts, the inclination being observed on the fronts equally with the sides of the building, and its angle being wholly independent of that of the roof.

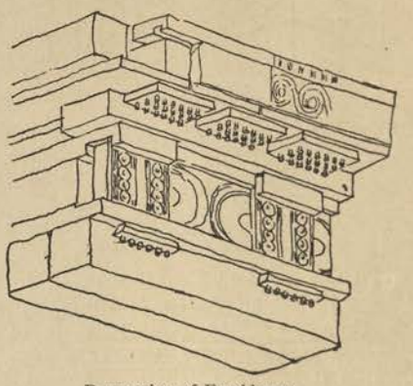
Viollet-le-Duc, describing the house of Chrenylus in his "Habitations of Man, &c." talks of the columns of Pentelican marble which support architraves of wood, surmounted by friezes and cornices overlaid with stucco and ornamented with delicate painting. He premises that wood suitable for building was by no means abundant in Greek lands, while there was a profusion of marble at hand. Columns and capitals of stone and marble were therefore substituted for those of wood, the capitals having a smaller development than the wooden prototype, lest they should break under their burden. He speaks of the Ionic as an earlier type than the Doric, and refers to it especially as derived from wood, while he refers to the Dorians as a people who, considering the want of relation existing between the Ionic capital and the material (marble), abandoned this traditional form of the wooden capital and adopted a new one springing naturally from the use of stone. This sturdy Doric capital at first projected considerably beyond the shaft of the column, but gradually received a more refined outline. Viollet-le-Duc then proceeds to discuss the wood or stone theory of the Doric entablature, and after a long dissertation, he goes on to say that "the form given to the entablature of the Doric order can be adapted with some unimportant variations to a structure in stone as well as of wood, in neither case involving the necessity of falsifying the form or the structure," and that it is scarcely admissible that a wooden original suggested the stone structure in the composition of the Doric order; indeed he would rather suppose the converse, especially since the further we go back into antiquity, the more the



Cornice pieces put together.

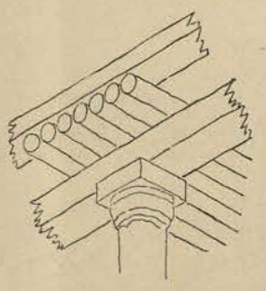


Separate pieces of Cornice.

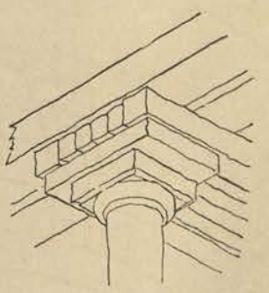


Restoration of Entablature.

Restoration of Mycenæan Palace by Perrot and Chipiez.



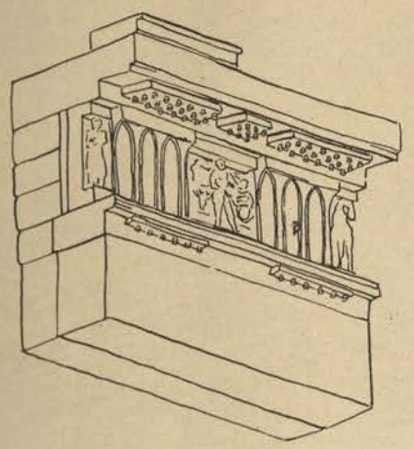
Mycenæan Palace: First epoch. Arrangement of woodwork.



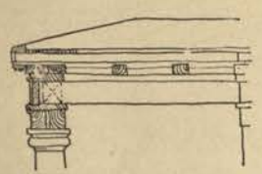
Mycenæan Palace: Second epoch. Arrangement of woodwork.

Early Types of Timber Construction.

entablature deviates from the style of the structure in wood, and conforms to that dictated by the use of stone. A later writer, Mr. H. H. Statham, in a recent work on architecture clearly disproves the wooden theory, and, with considerable justice, adds that whoever supports the theory of the wooden origin of the Doric column has to explain these facts :—(*i*) that the further back we go in the known and approximately dated examples, the thicker the columns are, while the reverse would probably have been the case had the original forms been wooden ; and (*ii*), that the characteristic moulding under the abacus of the Doric column is an essentially stone form, and one which it would not be at all easy to work in wood.



Entablature of Selinonte Temple.

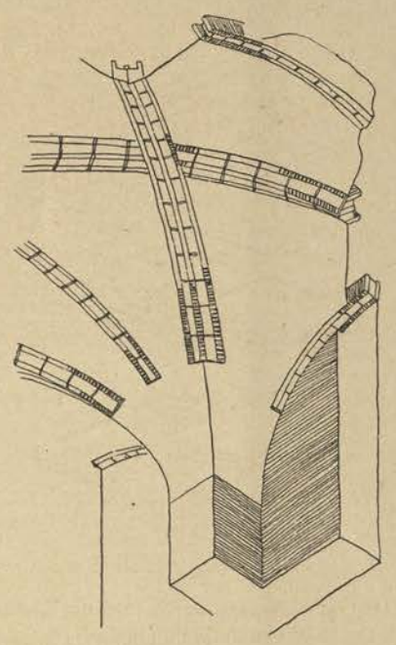


Mycenæan Palace : Longitudinal section through prodromos.

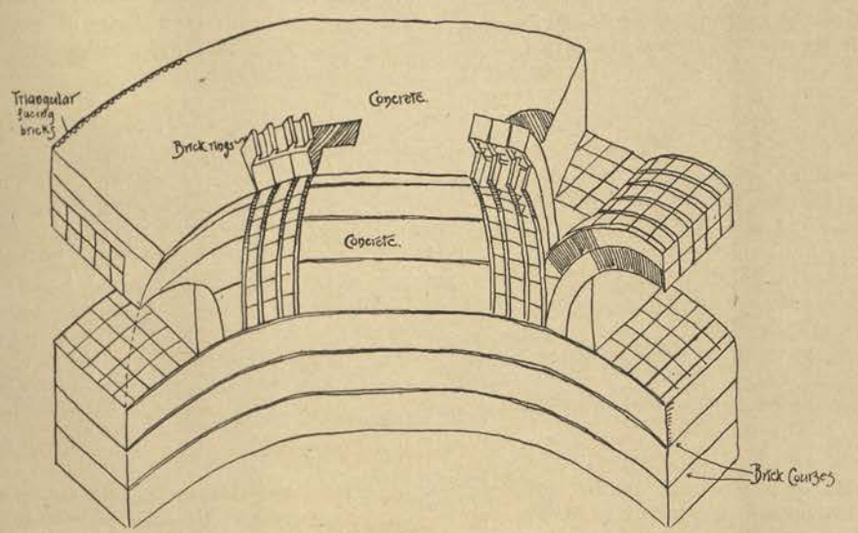
Origin of Greek Doric Entablature according to Viollet-le-Duc.

So much for the theories of origin. Further, in considering the effect of finely dressed marble blocks as a building material, it will be seen that the architecture of jointed stone gave rise to the lintel-statics in their simplest expression.

Stability was achieved solely by the judicious observance of the laws of gravity, mortar was unused, the adherence of the blocks of marble not being necessary ; for the weights in their structures only acted vertically, needing but vertical resistances. The supports were of necessity close together for the reason that stone or marble lintels could not be obtained beyond a certain length. In fact, the employment of hewn stone by itself directly shaped the development of the style. In matters of detail, that is, in the mouldings, features, and



Roman Construction : Baths of Diocletian. Concrete Vault with Brick Groining.



Roman Construction in Concrete on Brick Framework : Baths of Agrippa.

sculpture, the influence of the hard, fine-grained marble—which was employed in rendering possible the delicate adjustment and refined treatment practised in the structures of the great Hellenic period are clearly illustrated. This trabeated architecture necessitated and received great severity of architectural treatment; grandeur, refinement, and unity of effect were preferred to the more broken picturesqueness of the aggregated cells of the Egyptian temple as seen in perspective.

The absence of mortar referred to is only appreciated when the idea with which the Greeks regarded its use is understood. Even by the Romans it was only regarded as a means of aggregation, but the Greeks never thought of using it to transmit or equalise the pressure between the stones. In such constructions of large regular materials mortar was insufficient to produce such a result, therefore it was regarded as useless, and was not employed; the blocks were bound together by uniting them with pieces of iron strongly embedded. It is not only materials, but their method of application, which influences architecture, and in the case of the Temples of Pœstum and Ægina, Choisy has carefully examined into this, and he finds that the Greeks placed the stones on their natural bed or otherwise, according to the pressures they had to bear, and he finds that the architraves which had to support a cross pressure were placed with the planes of their beds in a vertical position as being better able to withstand the weight upon them, and enabling a wider intercolumniation to be obtained. This knowledge could only have been obtained by a careful use and study of materials.

What is simpler than placing a stone horizontally on two vertical supports? Yet from this simple principle what a numerous train of deductions were drawn by the Greeks.

CHAPTER IV.

ROME: STONE AND MARBLE TO BRICKWORK AND CONCRETE.

THE transition from Hellenic to Roman civilisation is that from the specialised culture of individual cities or small states to the universality of a world-wide empire.

Under such conditions the influence of materials is even more marked. Individual design tends to be absorbed in the stereotyped standards of officialism, and local types of construction are replaced by an uniform system.

How the Romans evolved from the simplest elements such methods of construction will become apparent in tracing the change from the Greek masonry to the Roman concrete.

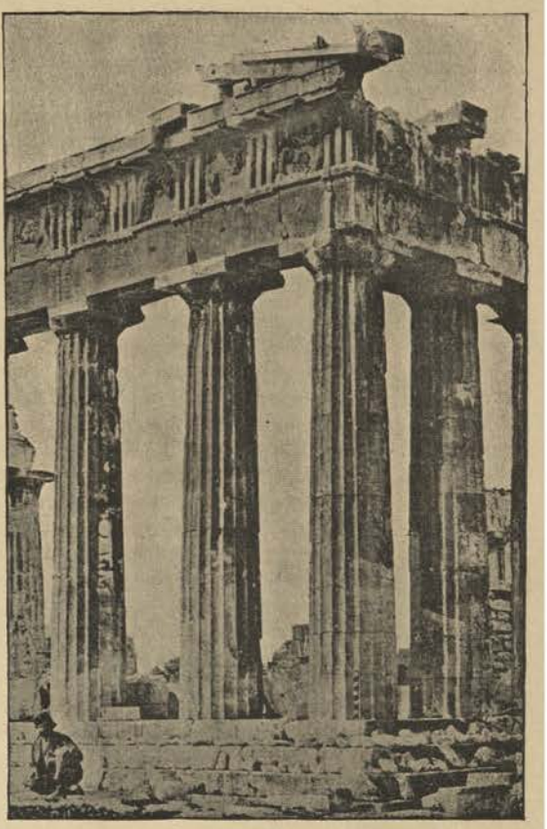
In the earlier periods the Romans employed the Greek system of jointed stone, close-fitting, and without mortar, as the Greeks had done; but in this case it was as a casing to the thick masses of walling composed of pebbles, rough stones, brick or rubble work, united by lime and sand.

The Greek method of building with large materials, blocks of stone, rough or cut, and without mortar, continued, however, to the last century before our era, being general in the monuments of the Republic. But the practical spirit of the Romans and their instinctive taste for simple things urged them to make in ordinary cases a more economical use of their immense riches. Instead of composing the body of their monuments of large blocks painfully placed in position, they sought by means of a procedure less expensive, and by expedients until then unknown, to inaugurate the employment in large masses of irregular materials reduced into fragments and bound together by mortar. The Romans were the first to found, upon the employment of such elements, a system of monumental construction which, with a rare sagacity, they adapted to their new needs. They profited by the facility with which walling composed of pebbles and mortar accommodates itself to the most diverse situations. Thus they contrived a method of building, as it were, universal, which was used with success in every district of the empire.

The materials which they made use of were not special to any country. The most shapeless ashlar stones, pieces of hard rock the least fit for cutting, small fragments of stone which would be rejected in our days as quarry débris, sufficed for the most important projects. The craftsmanship required was perfectly simple, for rough labour only sufficed. The buildings, composed, as it were, of plastic material, were modelled at the will of the architect, and could be erected by hands quite unused to the art of building. Cheap and plentiful labour, at hand everywhere in the empire, and at the direction of a central authority, naturally took its place among the influencing materials, and tended to uniformity. To carry their schemes into execution, the Romans had only to employ a certain amount of labour, it being immaterial by whom it was supplied—whether by slaves found on the spot itself, subjects liable to statute labour, or the Roman armies themselves, while the legal punishment of condemnation to working on public buildings was largely enforced. Any of these means, in default of trained masons, satisfied the needs of the builder, as all the operations consisted only in puddling the mortar and spreading over it the broken stones in uniform beds. From the time that lime and shapeless pebbles displaced the ashlar masonry of the Greeks, and allowed of the using by the empire of its vast resources of unskilled

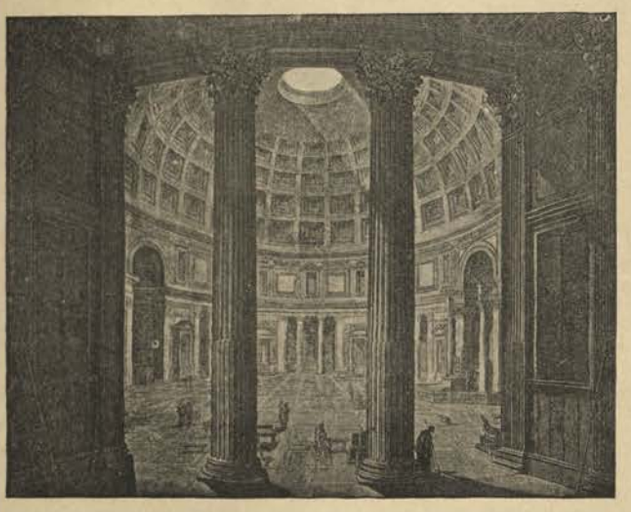
labour, the style of the Romans grew to be everywhere uniform and above the influence of local conditions; for through the colonies and legionary camps the new method penetrated to the extremities of the empire. They could improvise, at all the points where the rule of Rome extended, entire cities, recalling by their general traits the physiognomy of the metropolis, which cities became in their turn centres whence radiated the architectural ideas as well as the manners and customs of Rome.

The most important of all the constructive features employed by the Romans was the semicircular arch of jointed stones and the hemispherical and cradle vaults, the latter being further developed into the cross-vault. The arch had been previously used in Assyria, and the Etruscans, from whom it is supposed the Romans obtained it, had also used it; but the Romans were the first to carry it out as a structural system, and by its use they covered the largest areas even now in existence, roofed with such material. They not only used this kind of covering, which rests on all sides of the space to be covered, but also the simple or waggon-headed vault, which rests on only two sides of the covered rectangle. From the latter they invented the cross-vault, which exerts its whole pressure on the angles of the apartment. The beauty and advantages of this kind of vaulting led the Romans to use it over all corridors and long apartments, thus throwing the pressure of the vaulting on the points of division and leaving the remainder of the walls free for openings.



Angle of the Parthenon.

(Illustrating the age of marble in large blocks, and its influence on Greek trabeated construction.)



Roman Architecture: The Pantheon.

These three systems sufficed for everything, and the combination of their plans were simply the necessary result of these methods. For example, if a circular hall were built, they covered it with a hemisphere; if an oblong hall, whose lateral walls are sufficiently thick, they covered it with a cradle or half-cylinder vault; if a square hall, they covered it with a groined vault. If the oblong hall were very wide, if its side walls had to be pierced by large openings, thereby presenting only isolated points of support, they divided it into square bays (generally three, in order to get a central bay), and covered it with three groined vaults; that is to say, a longitudinal half-cylinder, intersected by three half-cylinders of equal diameter with the first—to such varying needs did the new method of the arch lend itself.

This is hardly the place to go into detail in regard to Roman construction. M. Choisy, in his "Art de Bâtir chez les Romains," has exhaustively treated of this, and he has described the different kinds of walling as (*a*) walling of concrete filling with stone facing, the concrete being in layers, and compressed; (*b*) walling in which each stone is placed directly on a bed of mortar; and (*c*) walling in which the separate employment of lime and pebbles was effected without previous mixing, but simply by being thrown in *in situ*. This was the most usual method—quick and rapid of execution, in which motives of

economy occupied entirely the mind of the Roman architect.

As to the arcuated system of construction, it will be seen at once that this employment of small materials influenced very largely, if not wholly, the development of the vault and dome—so essentially a part of Roman architecture.

Vaults of concrete had nowhere a usage so general as amongst the Romans; every ruin is filled with their débris, besides the fragments of masonry that exist as witnesses of the original structure. Such vaults were composed of brick ribs as guiding and permanent centres, with a filling of small material. They are found in an almost endless variety, and may be seen in turn covering rectangular enclosures besides rotundas, exhedræ, and recesses which are polygonal on plan. Being executed to rough moulds the system lent itself equally well to the most varied plans, and to the most numerous needs as regards distribution. The majestic simplicity of their forms gives to these edifices a severe grandeur which agrees well with the monuments of Roman greatness, and is specially appropriate to their material needs.

The Romans, then, were the first to generalise a system of vaulting at the end of the first century B.C., in making it simple and practicable by the employment of small material artificially bound together with mortar. The effect was far-reaching, and only here need be noted its effect on planning, in which it became necessary that the points of support should be placed with abutments for the thrust of vaults, which resulted in the production of structures as complex and as suited to the needs of the Romans as the simple Greek structures were to the Greeks.

In regard to the finishing or decoration of Roman buildings, sculpture was used as a mere decorative accessory without any connexion with the architecture. A Roman edifice built of rubble-work or bricks might receive a decoration of any or every kind of marble with no absolutely necessary connexion with the general character of the building. Such decoration was a kind of second structure whose richness did not belie the material used, nor the manner of using it. For when in Roman buildings the decoration was foreign to the structure, there was no attempt to conceal its own purpose.

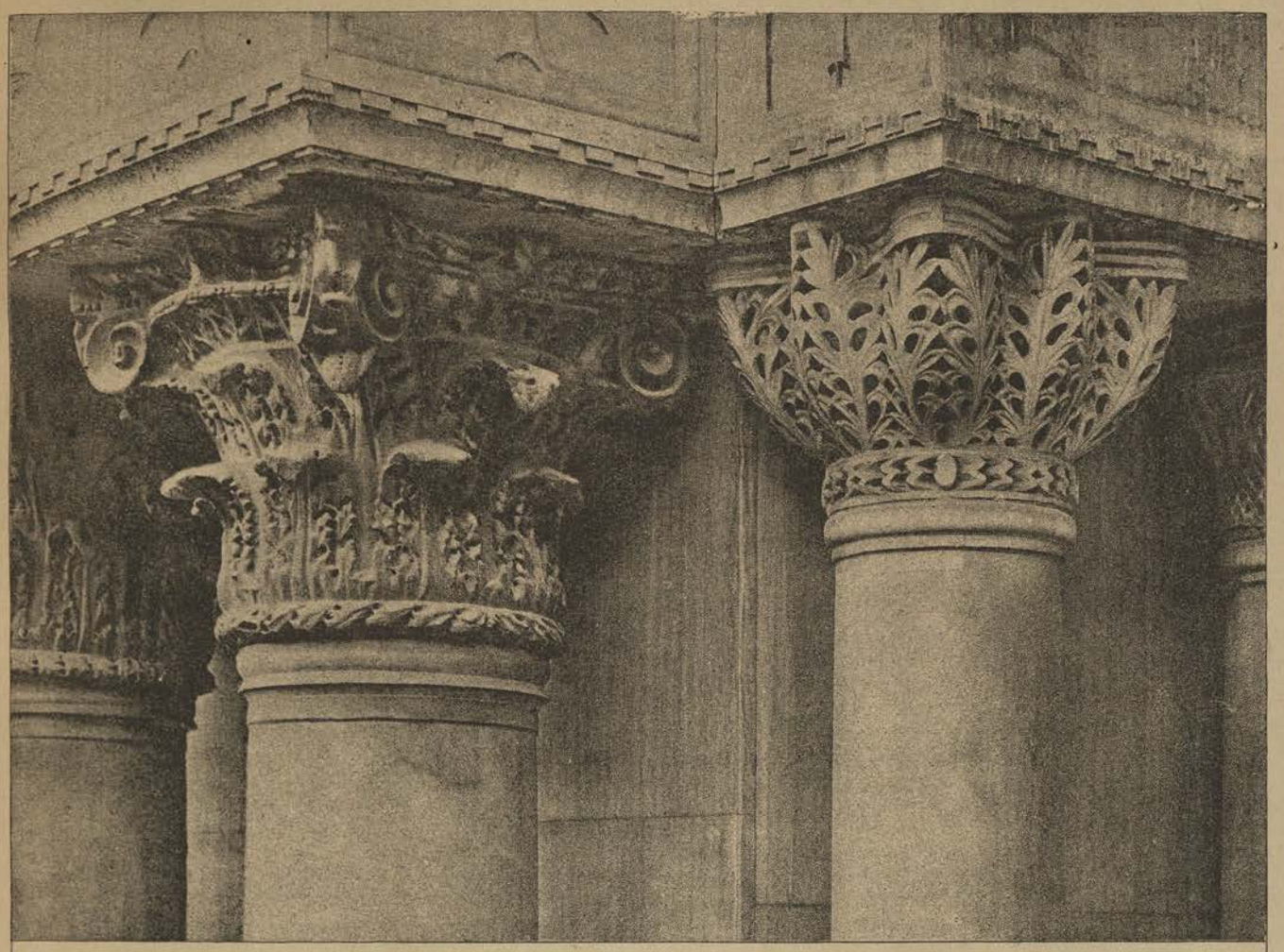
The Romans made it their chief object to employ every decorative material then obtainable — granite, jasper, porphyry, marble, painted stucco, bronze, and mosaic were used with profusion to produce the rich effect in which they revelled. Roman architecture is a clothed body; if the dress is properly fashioned it neither embarrasses nor distorts the form of the body, but is always a dress, which, as such, is rational and appropriate—rich for the rich, simple for the poor—and whose decoration disfigures neither the style nor the form.

What have the materials at hand done for architecture in this section? They have rendered possible the most gigantic structures of the world, they have facilitated the erection of buildings of every class, suited to every need; but at the loss to architecture of refinement, for the refinement of the Greeks was swept away, and the coarse material which was pressed into the service of architecture, especially in the provinces of the empire, largely accounted for the decline in technical and artistic workmanship which is so marked in the work of the later empire.

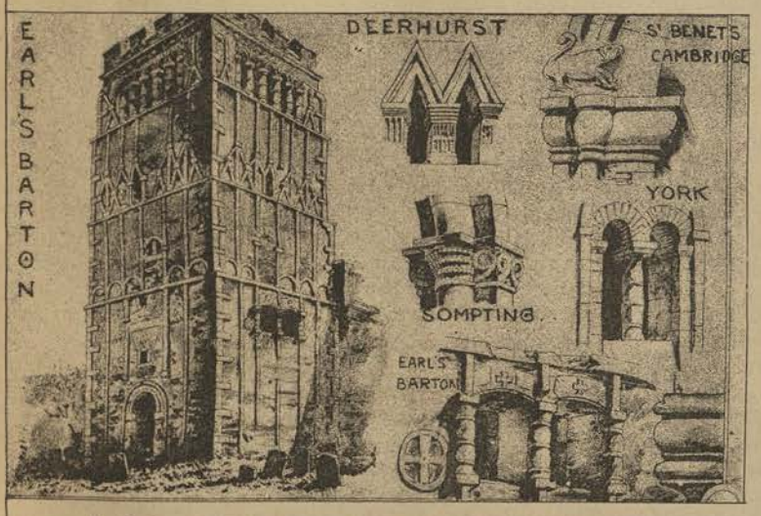
CHAPTER V.

ROME: THE FURTHER DEVELOPMENT OF BRICKWORK AND CONCRETE.

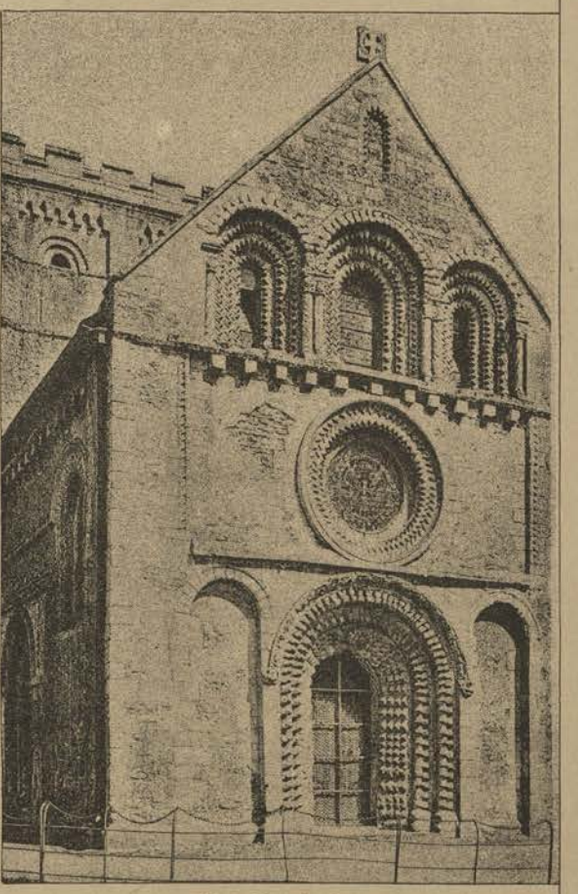
THE science of construction acquired by the Romans descended to the Byzantines. The construction of the walls with a brick facing and concrete interior is merely an extension of the Roman system, and need not be discussed. It was employed not only for walls, but also for vaults, bridges, and aqueducts. As has been pointed out, the building procedure was developed somewhat in this direction: the general form of the building being more or less decided, the first thing necessary was to collect monolithic marble shafts, and it was necessary to have a certain knowledge where such might be quarried or otherwise obtained, before even the foundations were prepared, for the columns decided the height and points of support of the building. These columns once assured, the body of the structure was proceeded with, as a brickwork shell without further dependence on the masons, who were only required to prepare the bases, capitals, and cornices, everything else being completed as a brick "carcase." The building was thus made of vast masses of thin bricks, the mortar composing half of the aggregate; when this had settled down and dried, the walls were sheeted with their marble covering, the vaults overlaid with mosaic, and the pavement laid down. In this way the carcase was completed at once, the bricklayers not having to wait for the masons; and, further, by reserving the application of the marble until the structure was dry and solid, it was possible to bring together unyielding marble and brickwork with large mortar joints that must have settled down very considerably. The independence of masonry unequally charged was a leading idea in Byzantine construction; indeed, it is obviously necessary when the quantity of mortar is so great that the brick at times becomes secondary in height to the joints.



Byzantine Capitals supporting arches of square section.



Anglo-Saxon work, shewing timber influence of earlier work.



Iffley Church, Oxon.

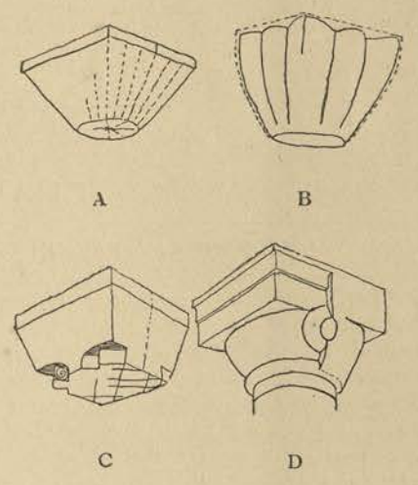
INK-PHOTO. SPRAGUE & Co 4 & 5 EAST HARDING STREET, FETTER LANE, E.C.

Brick, moreover, was the material preferred in the construction of churches; it lent itself best to all the caprices of the architect; and as the interiors were always lined with marble and mosaics, or decorated with paintings, such walls were the most suitable for the reception of these kinds of ornamentation. In countries abounding with good building stone we find the architects preferring to use brick. The forms of the bricks varied infinitely in Byzantine times, but the ordinary brick was like the Roman, an inch and a half in thickness, and was always laid upon a bed of mortar, at least half an inch in thickness. Moulds were used for the pieces forming cornices, and the shafts of columns when of this material were built of circular bricks.

In fact, brick-making was a feature of the period, and it is not surprising that the Byzantines took great pains with their fabrication when it is remembered that they were employed in their military as well as in their ecclesiastical and domestic architecture. The core of the wall was naturally of concrete, as in the Roman period, but the manner in which the bricks of the casing were arranged contributed greatly to the decoration of the exterior of buildings. They were laid, not always horizontally, but sometimes obliquely, sometimes arranged in the form of the meander fret, sometimes in the chevron or herring-bone pattern, and in many other forms of similar design, giving great richness and variety to the façades, as may be seen in the churches of Thessalonica. Further, the universal use of brickwork made the Byzantines pay great attention to their mortar, so much so that it remains at the present day as hard as that in the best buildings of Rome itself. It was composed of chalk, sand, and brick-dust. In vaulting, porous stones, especially pumice, were used; sometimes the domes were constructed of pottery, as at St. Vitale at Ravenna, where it is formed with urns and amphoræ placed side by side and grouted with mortar. It may also be said that Byzantine architecture was developed by the use of brick in the frankest and fullest manner, especially in domical vaulting, and that, further, an absence of preparatory and auxiliary work is remarkable. In this respect, M. Choisy remarks that, the "greater number of their vaults rose into space without any kind of support," (*i.e.*, without centreing) by the use of large flat bricks. Choisy further proceeds to say that it is quite a distinct system, not even derived from a Roman source, but Asiatic; and that Byzantine art is the Greek spirit working in Asiatic elements, for the dome on pendentives was invented and perfected entirely in the East. In the Byzantine system of vaulting, the vault surfaces gave the conditions of the problem and the groins or angles of intersections were of secondary importance; presenting a direct contrast to the mediæval buildings of Europe.

In regard to exteriors, from the time when the architect permitted the forms of the vaults and arches to appear in the exterior decoration of the façades, the regular entablatures of the Romans were abandoned, and in the church of S. Sophia we see the fully developed Roman style. For whereas in the older buildings of Rome, the columns and entablatures could be and have been removed without causing the ruin of the building, in S. Sophia the true Greek expression of truth in construction is reverted to, its columns and capitals being not merely ornamental, but really supporting the structure. In continuation of Greek principles the capitals even assume a novel form, appropriate to their new purpose of receiving the springers of arches, the voussoirs of which were always square, and not set in receding planes as in so-called Gothic architecture.

As Freeman says:—"The problem was to bring the arch and column into union,—in other words, to teach the column to support the arch." This was done by shaping the block of marble which formed the capital so that a simple transition from the square block to the circle of the column was formed." There were four main types of capital used by the Byzantines, and these are found in S. Sophia (see figs. A, B, C, D, and lithograph plate).



A B C D

Further, as Swainson and Lethaby say, the numerous round shafts of S. Sophia exhibit a remarkable and beautiful structural expedient, by which the necking is entirely suppressed, and bronze amulets surround the shafts under the capital and above the base. This method prevents the shafts from sliding or splitting, and retains the lead beds from being forced out by the weight (Choisy), for large monolithic shafts were the more apt to split, as they had to be set up contrary to the direction of the quarry strata.

In Byzantium, ornamentation and structure were intimately united.

In regard to decoration, although columns of the richest marbles were taken from old buildings, the importation and sale of decorative materials, such as rare marbles, did not in the least decline. The Theodosian code in fact encouraged this branch of trade and industry, and the mode of ornamentation by means of coloured marbles was carried to a greater extent than ever before. The quarries opened by the Romans were care-

fully preserved for decorative purposes, and the workmen employed in them governed by imperial decrees issued specially for their guidance.

In the Byzantine period no church was founded in which mosaic did not add its splendour to that of sculpture and precious stones. The decoration of St. Sophia and the domes and apses of all the churches of Nicæa and Thessalonica show the perfection to which this art had been carried.

But, further, the use of natural stones in mosaics and inlaid pavements had been abolished, and the art of enamelling had arrived at perfection. All the mosaics which still adorn these domes and apses are of coloured enamel, that is to say, of glass rendered opaque by oxide of tin. The invention of gilt glass for the ground of pictures in mosaic was, nevertheless, anterior to the reign of Justinian.

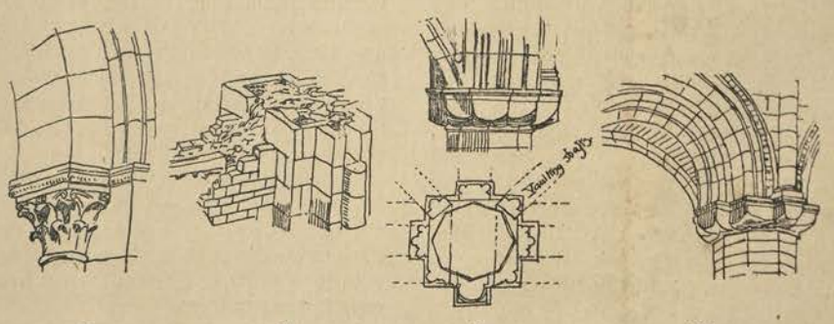
To sum up the influence of material, we find that from the possession and extensive use of these rich marbles, a flat treatment, with an absence of mouldings, cornices, and modillions prevailed, while externally the use of coloured bricks is seen in conjunction with stone; that mouldings were subordinate to the decorative treatment in marble mosaic; and that the simple treatment of the exteriors in flat expanses of brickwork did not leave the same scope for mouldings as in other styles. Flat splays enriched by incised or low relief ornamentation were introduced, and in general mosaic and marbles were used, in a broad way, as a complete lining to a rough carcass; architectural lines were replaced by decorative bands in the mosaic, which was worked on rounded angles. One surface melts into another as the mosaic sheet creeps from arch to pendentive up to the dome; while the gold of the background is carried into the figures, and unity of surface thus always maintained.

In Byzantine buildings, then, the logical outcome of Roman methods of construction is seen; dome and vault are here freed from the Greek trabeated system, and advanced to the dignity of a style, through the acceptance of a novel principle and the discovery of an architectural expression suited to it. The use of rough and small materials involved the constructive principle of the arch, dome, and vault, and these forms were the elements of the new style; the development of which was further extended by the influence of material in the creation of fresh and expressive details adapted to its forms.

CHAPTER VI.

ROMANESQUE: A PERIOD OF DESTRUCTION AND UPHEAVAL.

GIVEN an ancient civilisation of vast extent, devoid of physical force, and recognisable only by the multitude of its monuments, some intact, others injured, partially destroyed, all unguarded, and most of them disused—a calamity which happens in due course to every great nation or group of peoples—then, and in no poetical sense, but sadly prosaic in its realities, "all save the spirit of man is divine." But slowly, and with many a contortion, many a yawn, this same man throws off the sleep of ages and awakens to a sense of the treasure he possesses, of the wants he begins to understand, of the means to the ends he would attain. In his midst are ruins of vast edifices, some still standing among heaps of stones hewn and carved, of sculptured capitals and friezes, of monoliths of porphyry and marble, while his own shelter affords him little protection either in cold or sunny weather. What happened? As time went on he gathered up the smaller fragments and arranged them perhaps upon the foundations, still intact, of an ancient building, and as he gradually acquired a knowledge of the uses to which he might apply this and that fragment, he insensibly produced something that learned men of two hundred years ago dubbed Romanesque. This vividly explains the true birth of Romanesque, for it is certain that the quarry of the ruins of ancient buildings



E F G H

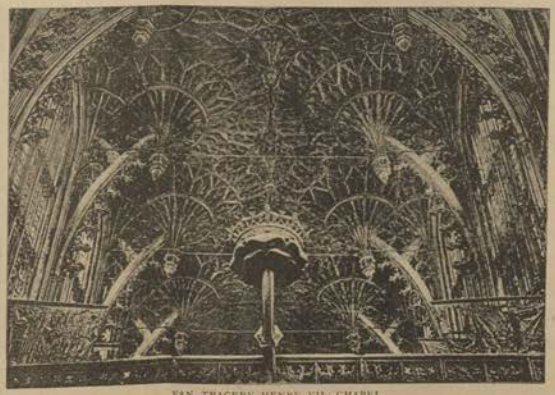
E.—Romanesque capital to take square impost of arch-stone. F.—Romanesque walling, ashlar with rubble filling. G, H.—Piers, choir aisle, Peterborough.

COUTANCES.

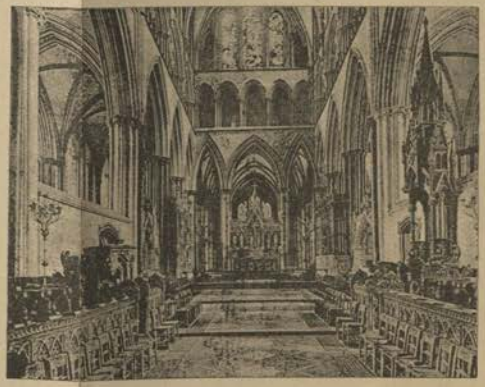
ROUEN.

AMIENS.

WESTMINSTER.



FAN TRACERY HENRY VII. CHAPEL.



SALISBURY.

largely influenced the work done both in construction and decorative treatment, in that the new buildings were generally built from the remains of ancient Roman buildings in the vicinity, and for this reason, although extremely interesting from an archæological point of view, the buildings can hardly have, in the architect's mind at least, the value for study which a new manner in architecture, arising from new structural conditions, is certain to possess.

In Italy there were various early Christian edifices erected at Ravenna from the fifth to the seventh centuries. Ravenna was the principal city in Italy during this period, being the seat of the Exarch or representative of the Byzantine Emperor in the western part of his dominions. These buildings partake, naturally, of the elements of the then fully developed Byzantine style, in the same way as St. Mark's, Venice, the prototype of St. Front at Perigueux, was the result of the close connexion of these centres with the trade and commerce of the East.

Turning to France, we find that in Aquitania and the West of France during the eleventh and twelfth centuries the old traditional basilican plan was preferred and adhered to (except at St. Front); but the dome raised on pendentives became the common kind of vaulting, in conjunction with the single or aisleless nave. It should be noted, however, that the use of the Pointed arch occurred in the South of France sooner than in the North, and it is considered by some that it was derived from contact with the Saracens, who invaded this portion of France from 719-732. Further, the development of monasteries in the eleventh century gave a great impulse to civilisation and agriculture, and exercised great influence on architecture. Provence was, moreover, in the twelfth and thirteenth centuries the chief entrepot of the growing traffic from the East, and the highway by which artistic and other products of the Levant were dispersed through France and the North of Europe. Similarly, the development from Roman to Gothic art was accomplished by the ordeal of the destructive, though purifying, dissolution of the Dark Ages, whence the true spirit of Roman construction emerged, cleared to a great extent of the extraneous elements with which it had been so long encrusted. Up to the end of the twelfth century the Provençal architects had led the way, but at this period the lay architects of the North, seizing on the Provençal principle of the Pointed arch, soon developed from it the magnificent Gothic system of the perfected architecture of the thirteenth century.

Let us glance at England. After the departure of the Romans we find a wild and barbarous people whose only idea in art was naturally to use the materials which the Romans had quarried for their own purposes for the erection of their houses, baths, basilicas, &c., but as these remnants of Roman rule became scarcer, the use of wood, which was the natural building material of the time, was developed. We know from the chronicler Henry that churches were erected in this material quite up to Norman times. Now, the use of timber distinctly influenced the contemporaneous and succeeding architecture. The "long and short" work, the balustered windows, and the timber forms exhibited in such examples as Earl's Barton are properly copies in stone of a timber original* (see lithograph plate).

By the time of the Normans these timber forms had disappeared, owing to the increasing use of stone. Putting aside spasmodic efforts, the period of the tenth to the twelfth centuries is remarkable for the tentative employment of a new manner in construction and of a new material. The first is the principle of equilibrium which succeeds to that of inert stability as used by the Romans, and the second is the employment of dressed stonework in comparatively small pieces, and connected with mortar beds of considerable thickness. This was a method not before attempted, because the materials in use up to that time had not demanded it. By this new system of employment in materials, the whole current of architecture was turned to a constructive system which should answer to its needs, and which, after many tentative experiments, was to lead to the next glorious period of our subject, in which elasticity of structure is joined to the principle of equilibrium.

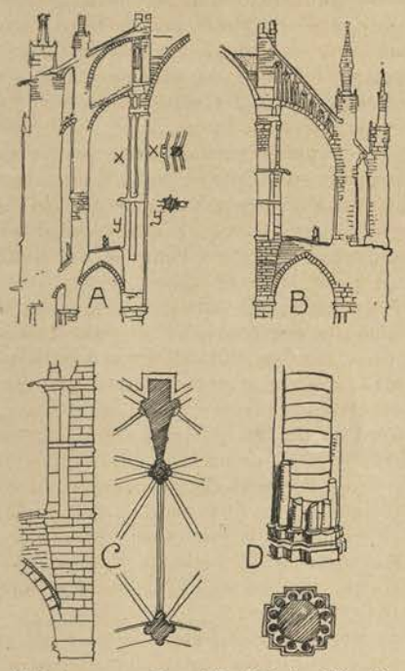
CHAPTER VII.

THE GOTHIC STYLE: THE AGE OF STONE.
EXCURSUS: BYE-PATHS OF GLASS, MARBLE, TERRA-COTTA, BRICK, WOOD, AND IRON.

THE fully developed Gothic art of the thirteenth century was the style which had been slowly developing itself throughout Europe as a necessary sequence of the Romanesque style. It is by destruction, and modification akin to destruction, that architecture has always developed and progressed. By resuscitation and evolution, and only by such means, has it survived as a living art. To quote Darwin, "From the war of nature, from famine, and from death, the most exalted object which we are capable of conceiving, namely, the production of the higher

* This, however, has been disputed by saying that these forms are the descendants of the Classic column or pilaster.

animals, directly follows . . . . from so simple a beginning, endless forms, most beautiful and most wonderful, have been and are being evolved."



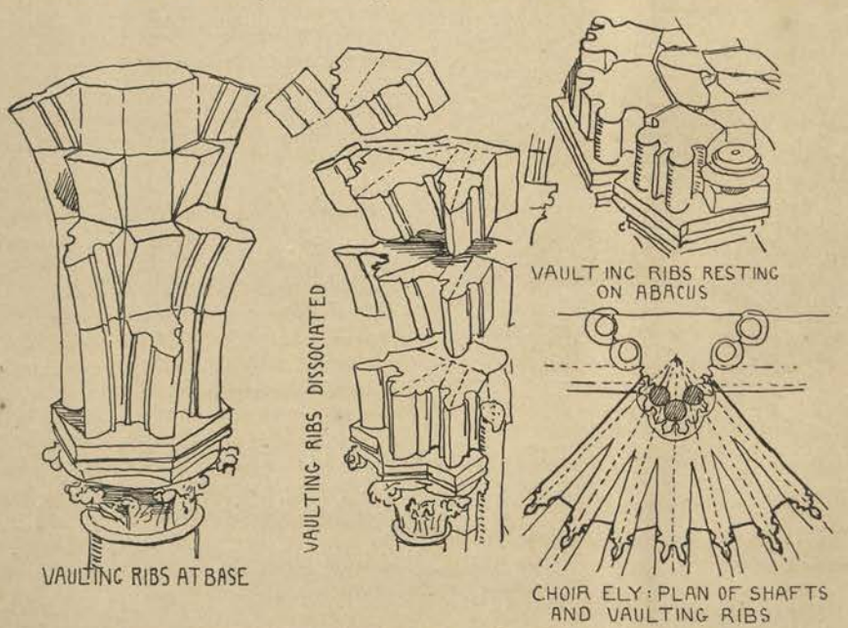
A—Flying buttress at Beauvais.
B—Chancel buttress, Amiens.
C—Plan and section of portion of Chancel, Amiens.
D—Aisle piers, Nôtre Dame, Paris (coursed stone in conjunction with shafts set against the strata).

Principles of Gothic Construction: Elasticity and Equilibrium.

In this period—the thirteenth and fourteenth, and fifteenth centuries—the Gothic masons were exhausting the possibilities of stone as a building material. They heaped it up in towers that rose on open archways through the lofty roofs of the surrounding naves, and tapered away in shell-like spires embroidered in all the fretwork of Gothic tracery. They hung it aloft in ponderous vaults treated by art to seem the gossamer web of nature, scarce capable of bearing the stalactite pendants in which the latent fancy of the latest age found its expression. Eventually pushing their practice to the furthest boundaries, they cut the granular stone to the thinness of fibrous wood or iron, and revelled in tricks of construction and marvels of workmanship that astonish our inexpertness. (See illustrations of Gothic buildings in separate plate).

In the thirteenth century the Gothic spirit, taking account of mechanical forces, employed materials at hand according to their nature; it sought for those laws of elasticity and equilibrium which were to be substituted for those of inert stability, the only laws known to the Greeks and Romans. It studied how to economise material, because it was so forced to elevate human labour from being the mere carrier of material, to the highest form of technical art and skill.

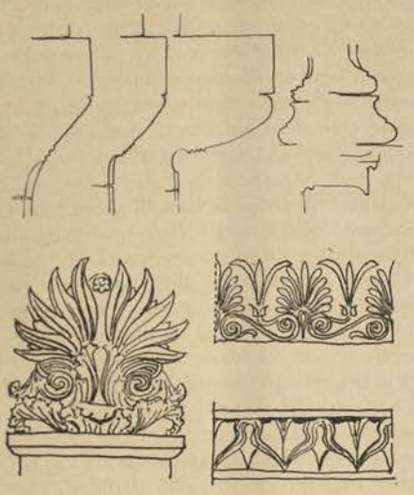
In the Romanesque period, the walling generally consisted of a rubble core between two faces of stonework, but at the beginning of the thirteenth century, edifices higher and of larger extent being built, a new method was gradually evolved. For, in seeking to diminish the thickness of the interior supports and of the walls, it was necessary for the architects on the one hand to find a mode of construction more homogeneous and capable of resistance, and on the other to avoid the expense of labour which the carrying of material of large size involved. Large facing stones were therefore more and more discarded, and stones with thick mortar joints, and small enough to be carried on a man's back, were gradually introduced, and were employed throughout the thickness of the wall; this method is a middle course between the Roman construction in large facing stones, and that of rough stones included between brick and stone walls.


VAULTING RIBS AT BASE
VAULTING RIBS DISSOCIATED
VAULTING RIBS RESTING ON ABACUS
CHOIR ELY: PLAN OF SHAFTS AND VAULTING RIBS

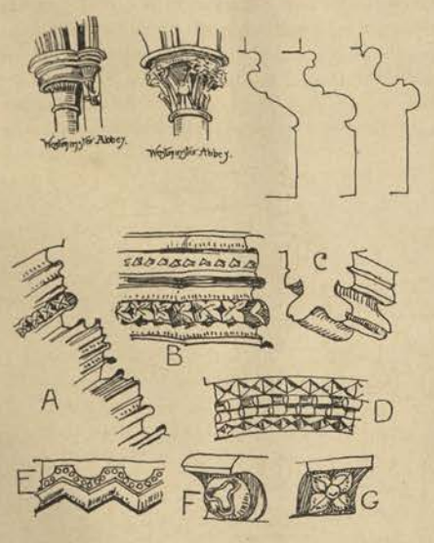
Gothic Construction: Shallow beds with thick mortar joints.

In a word, the architecture was readily subjected to the means at command, for the architecture of the thirteenth century was

adapted to a structure of small stones rather than to one of jointed blocks, and was a compromise between Roman rubble work and the use of jointed stones without mortar. The military organisation, which had helped to mould the Roman style, was, of course, wanting in the Gothic period, when stone was sought in various quarries from different proprietors and transported at the builder's expense or with voluntary aid; for the workmen were forced labourers, doing as little as possible, and taken away, ever and anon, to fight in their owner's battles. In regard to the material at hand, it must be observed



Greek Detail: Marble.



A—Haseley, Oxon.
B—York.
C—Temple Church.
D—Billet
E—Chevron.
F—Ball Flower.
G—Four-leaved Flower.

English Gothic Detail: Coarse Stone.

that the Gothic architects of Western Europe possessed stone that was strong and hard, but which split in thin pieces; they had not at their disposal either the marble of Pentelicus or the blocks of granite which the Romans procured from Corsica, the Alps, and the East; they were absolutely compelled to erect considerable buildings with thin courses of stone, thus largely moulding the style, whereas the Greeks erected small buildings with enormous blocks of marble.

This condition would naturally influence the forms given to the architecture even in the vertical parts.

In regard to constructive features, the Gothic builders contented themselves with forming the transverse and diagonal ribs of their new system of vaulting on centres, timber in quantities required for centering as in Roman vaults, and materials for their construction, not being at hand; and these arches became permanent centres on which the panels or "filling in" of thin stone could rest. This arrangement enabled the building to be erected all at once or in parts without disadvantage to the solidity of the edifice. This use of stone as against the concrete of the Roman period gave the elasticity to the building which enabled it to yield to strain without rending, and this, in its turn, was a *primâ facie* reason for the non-employment of a concrete or homogeneous mass.

Among the early Gothic architects the arch absolutely determined the form of the support. The arch determined not only the structure but the form which it took, and the architecture is dictated solely by the arch. Thus material, through the form which it dictates, may be said to influence architecture in this period.

In any true architecture form is not the result of caprice; it is only the expression of the structure. The column is a real support; if its capital is expanded, it is to sustain a load; if the mouldings and ornaments are developed, it is because such development is necessary. If the vaults are divided by ribs it is because these ribs are so many sinews performing a function. Every vertical support depends for its stability on being stayed and weighted; every arch-thrust meets another which counteracts it. In this period walls as supports no longer occur; they have become mere enclosures, and the entire system consists of a framework which maintains itself, not by its inert mass, as in Roman construction, but by the combination of oblique forces neutralising each other. No such system of construction, it is evident, could have been developed without the employment of such a material as stone, laid in tolerably small courses with mortar joints, which gave the necessary elasticity to the various pressures.

This system, through the material used, shaped the mouldings, which fulfilled a useful function, protecting the architectural members externally, as in the case of eaves, courses, hood moulds, &c., and internally by jutting forward provide corbels and springers. Further, the comparative scarcity of materials taught the Gothic architects to practise economy in their use; this, no doubt, helped towards the evolution of the characteristic mouldings of the mediæval period, which exhibit much less waste of material than those common in Classic times.

Every new erection was a step towards the limits assigned by the material at the disposal of the architect.

In the Middle Ages the structure is decorated, it is the naked body to which an attractive form is sought to be given, and it is in this particular that the architecture of

this period stands in such close relation to Greek art. The same principle of truth was upheld, but now the form had changed.

It is no longer the self-contained Greek temple, reposeful in the severity of horizontal lines, but a complex, restless structure whose aspiring tendencies find expression in vertical grouping. There is unity in the whole because there is an exact and necessary correlation between all the parts.

Excursus:

Bye-Paths of Glass, Marble, Terra-Cotta, Brick, Wood, and Iron.

So far as internal architecture is concerned the invention of painted glass was perhaps the most beautiful ever made. Neither the painted sculpture and hieroglyphics of the Egyptian temples, the coloured and sculptured slabs of the Assyrian palaces, the paintings of the Greek temples, nor the mosaics and frescoes of the Byzantine and Romanesque periods produced colour effects that can be compared with the brilliancy and the many-tinted splendours of the transparent walls of a Gothic cathedral, alive in its windows, a blaze of glorious colouring. In the north and west of Europe, where this material is the principal mode of decoration, the walls were kept internally as flat as possible, so as to allow the windows to be seen in every direction, while all the mechanical expedients of piers and flying buttresses are placed on the outside to facilitate the introduction of this new material—glass. Even further, when by the grouping of windows and the subsequent formation of mullions and tracery, the entire screen wall between the piers came to be occupied by bright coloured windows, these windows of necessity took the pointed form of the vault, in place of the previous semi-circular; the pointed form having been originally adopted for constructive reasons arising from the progress of the art of vaulting, which was further influenced by the desire for lofty windows to act as frames for the glass.

The influence of marble in Northern and Central Italy caused a divergence from the Northern Gothic type. In Italy the abundant and beautiful coloured marbles induced the elaboration of a plain wall treatment that reduced mouldings to flatness and comparative unimportance as in the cathedrals of Florence, Sienna, and Orvieto, or in such Venetian palaces as the example given in the lithograph, where the architect relies for effect ot light and shade on disposition and colour alone. The influence is also seen in Greek and Italian Sculpture, which differs from the rude work of Northern Europe, partaking, as it did, of almost classical purity.

In Byzantium, the pierced lattices of the windows also furnish examples of another beautiful method of marble slab construction. The large windows at St. Sophia are sub-divided by marble posts, between which the pierced lattices make a mere screen. The western windows are similarly pierced out of sheet marble with a meander carved on the bars. The lower part of the window openings are fitted with marble closures, sometimes of translucent *phengites*, through which the light shone. In St. Sophia the architects used bronze formed into panels on a wood frame, and with panel margins of cast bronze, decorated with meanders, frets, and leaf mouldings, delicately modelled in high relief, as an addition to the rich and effective interior.

In the use of terra-cotta and brickwork, especially in Italy, the influence is evident, the plastic state of the material rendered abundance of ornament easy of application, and a smallness of detail followed, which was eminently suited to the material, as, for example, at the Frari Church at Venice and elsewhere (see lithograph).

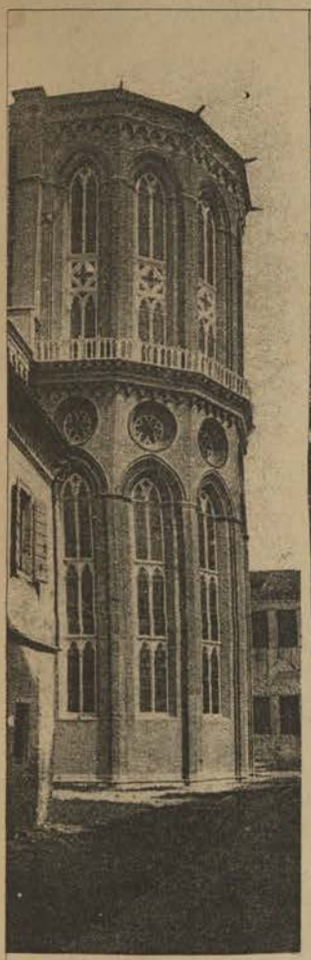
The treatment of moulded brickwork has never been carried further to perfection than in North Italy during the Gothic and Early Renaissance period, especially in civic buildings. The effect of sublimity is perhaps not to be obtained in so small a material unless used in the broad massive manner of the Romans. On the other hand, there is no beauty of detail or of design on a small scale that may not be obtained by the use of moulded bricks; which, if carefully burnt, are as durable as most kinds of stone.

The Italian use of brickwork was essentially the right one; the details were small and designed with taste, and the effect of variegated colour was relied on instead of depth of shadow—a perfectly legitimate use of light and shade and warmth where small materials are used, and in which stone of different colour is carried systematically in patterns through the design, and gives a special character, as at Verona. A flatness and want of shadow is necessarily characteristic of brick buildings, sufficient projection not being obtainable for cornices; but such can scarcely be deemed a fault in the material. It was, however, always tolerated by the Italians, who allowed the material to express its own capabilities without trying to disturb its architectural function.

In Northern Germany, in the valley of the Elbe, a brick architecture was developed as at Lubeck and the neighbouring cities, which, although not equalling that in the valley of the Po, has that special character belonging properly to the material, although expressed in a somewhat meagre manner.

The influence of wood as a constructive material produced a class of buildings of which Moreton Hall (see lithograph) is a type, and which were erected during the later Middle Ages when abundance of timber was at hand. These buildings well express the functions of the material.

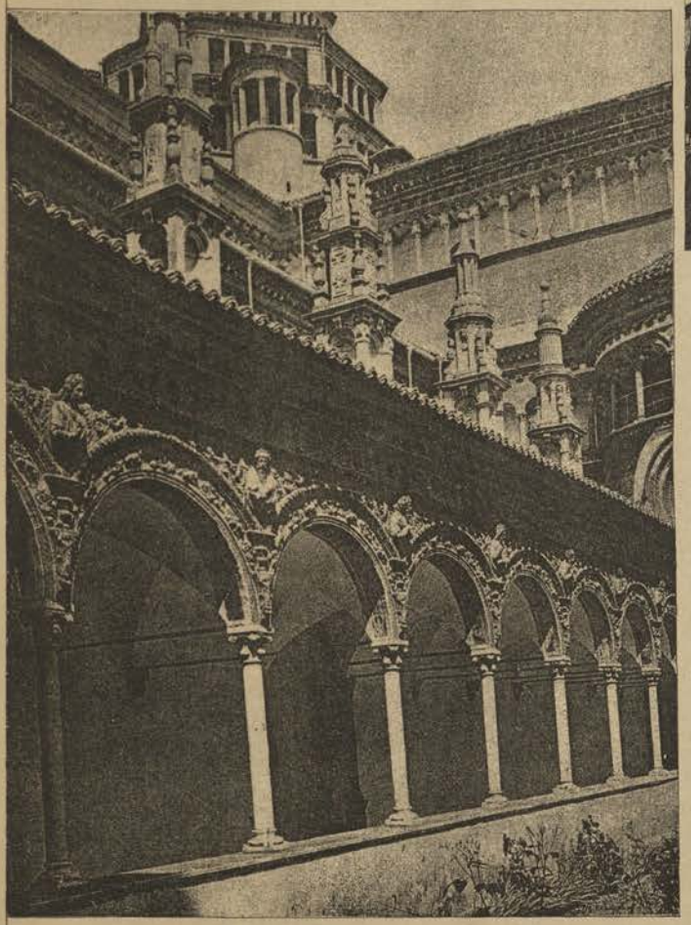
Decorative ironwork has in the past added largely to the character of different periods, and reference need only be made to the Spanish "rejas," rich in their fanciful detail, and sparkling as if fresh from the smith's forge, in a stream of sunlight darting across the dark nave of some Spanish church, to remind one of the liturgic mysticism of the mediæval periods.



Brick Influence: Venice.

Wood and plaster type: England.

Influence of brick on smallness and repetition of detail: Piacenza.



Influence of plastic terra-cotta on richness and smallness of detail: Pavia.

A Venetian Palace: marble surface colouring and inlay.

INK-PHOTO: SPRAGUE & CO. 4 & 5, EAST HARDING STREET, FETTER LANE, E.C.

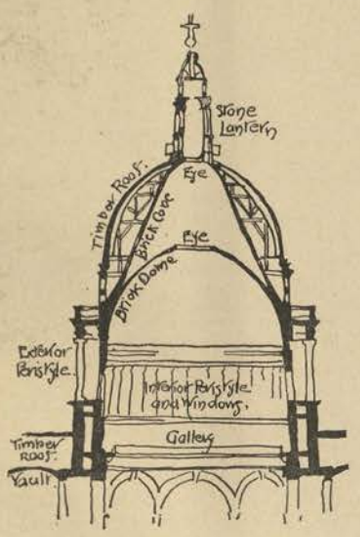
CHAPTER VIII.

THE RENAISSANCE PERIOD: A PERIOD OF UPHEAVAL AND DESTRUCTION. STYLE LARGELY INDEPENDENT OF THE INFLUENCE OF MATERIAL.

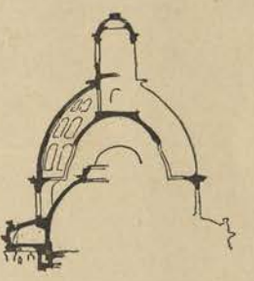
THE Renaissance of the fifteenth century in Italy, and of the sixteenth century in other parts of Western Europe, was a period of destruction—a break in that orderly evolution of architecture which is based on the nature and necessities of materials.

In place of such evolution we have the worship of style, that is of the past results of the nature of materials as formulated into systems. Such results were worshipped for their own sake, and applied regardless of the materials of their execution. The designer is revenged for the trials and perplexities of his long subjection to the duress of Nature, and now carries out his design even in the face of the nature of the material he employs.

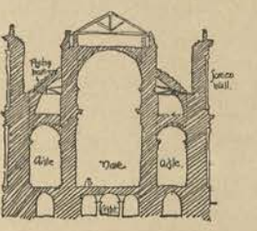
The falsity, however, of this Renaissance school of design is evident when we trace back to the roots the origin of its characteristic features.



Sketch Section of Dome, St. Paul's.



Sketch Section of Dome, Pantheon, Paris.



Sketch Section of Nave, St. Paul's.

History points out that there is no escape from the influence of material, nor from any feature, however arbitrarily developed subsequently, that had not its origin in the special qualities of some material and structural requirement to which it owes its birth.

In the fifteenth century Italy, the headquarters of the new movement, possessed skilful jewellers and excellent medallists, and it was by their help that the Renaissance commenced and expanded. From their well-known good taste, architects consulted them, and often, indeed, were their pupils, as Ghiberti, Donatello, and Brunellesco. Men, therefore, who were at once painters, sculptors, architects, silversmiths, jewellers, and goldsmiths, only looked, somewhat naturally, at the finished results as the goal to be aimed at, and were not troubled about the means to such an end. Again, the development of the schools of painting had their influence on architecture, and aided the other influences which caused structures to be looked upon as works of art unaffected by materials, instead of being dependent solely for their form and effect on materials. In the same manner, and for the same reasons, the period may be looked on as the age of accessories, in which iron work, gold and silver work, tombs, monuments, altars, fonts, fountains, were designed in great numbers, and, by the whim and fancifulness of the designer, in large measure affected architecture, which henceforth ceased to be the governing art.

The truth of this proposition may be deduced from the fact that, whereas in previous periods materials, as they arose, were successfully worked into the general progress of architecture to form part of the whole scheme, and to be the creative force of each new style, new materials were scorned or misapplied Driven outside the pale of art such new materials grow up as Ishmaelites, develop in artless forms, drawing their strength from the stern facts of utility and necessity, which compel their application in structures no longer conventionally recognised as architecture. The Renaissance application of new materials has been in the form of substitutes and shams, and this last result is a natural outcome of the system of design, for if a design of Palladio, say, is a true model of proportion and beauty, it is so as a composition of features or orders, which within certain lines is capable of execution to any scale and must be equally effective also within extreme limits in any materials.

To comply with the canon of absolute beauty is the primary necessity, and indifference to materials is the inevitable consequence. Herein is the only possible

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defence of falsity of material, and the widespread use of the spurious and the sham throughout the Renaissance epoch was not a casual incident nor wholly without reason. In another aspect, the canonised system of design has had a profound influence, for buildings of the common class being incapable, either from expense or from a sense of inappropriateness, of treatment by its formulæ—the Classic orders, &c.—were ruled out of architecture altogether and left to find out some treatment of their own. Thus the greatest success of modern art in architecture has been the rescue of the small villa, house, and cottage from degradation, and this triumph has been achieved through learning from the same procedure of old country buildings the scope and influence of materials.

Speaking generally, we may note that in this period there is an endeavour to reconcile the Gothic and the Roman method of construction, *i.e.*, the body and the dress are one and the same thing constructively, because the architects of these times, attracted by the mere external appearance of ancient Roman art—the only one they had been able to study—and not perceiving that this form was merely an envelope, and not the real structure, continued in the matter of construction to follow the traditions of the Middle Ages, which, as before stated, did not separate the structure from the decoration.

The influence of material in the preceding styles is an important factor, as is also the method of working such material. In the Gothic period each stone was finished, moulded, and sculptured in the workshops before being laid—a method which produced skilful and intelligent masons and stone dressers, and obliged the sculptor to make the decoration suit each piece of stone. In the Renaissance period the new mouldings and carvings could be executed with more exactitude and less expense in situ, thenceforward the necessity of making the jointing accord with the various members of the architecture was no longer imperiously felt, and this negligence often resulted in a total want of harmony between the jointing and the architectural features which were continuous, taking no account of the former but cut on the building itself as a mere block. Form is the leading consideration in this epoch; old principles were no longer regarded, and structural system there was none. The division between designer and builder widens and deepens, and the results of this separation will be seen in the next chapter.

CHAPTER IX.

MODERN ARCHITECTURE: A MIXED PERIOD, THE AGE OF IRON AND STEEL.

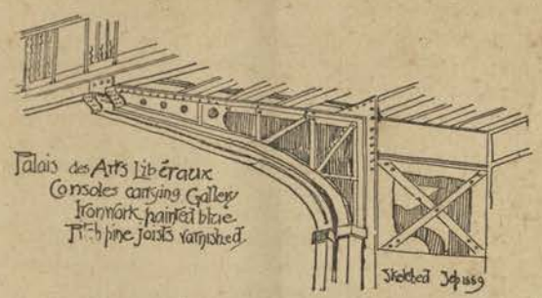
IN previous periods it has been shown that styles of architecture are largely the outcome of material. What can be said, then, of a period which has in turn tried all styles, and at times, all in the same material? Since the Renaissance we have had a Greek style, a Gothic style, and various phases of both of them, produced quite independently of the materials at our command, and, in fact, in spite of them. For whereas in previous styles science has been called to aid in the erection of buildings, in modern times it has played the part of the dresser and maker-up of a theatrical architecture where each period in turn occupies the scene.

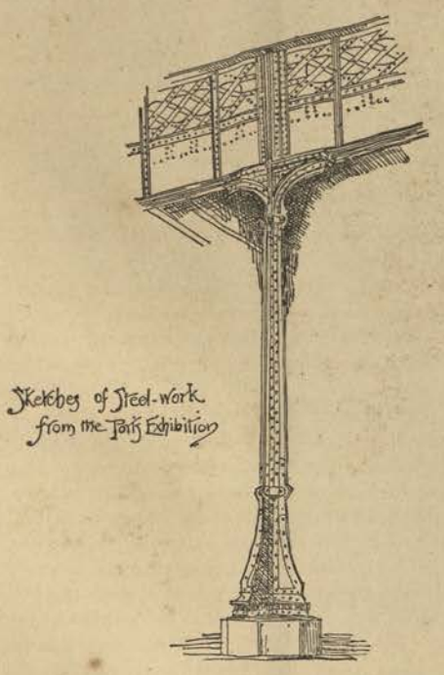
Endeavouring at the beginning of the century to reproduce the forms of classical art, without taking any trouble to analyse and develop their principles, architecture has been incessantly hastening to its decay. It has become Neo-Greek, Neo-Gothic, Neo-Roman, Neo-Renaissance, Neo-Romanesque; it has sought its inspiration in the caprices of the age of Henry VIII. and Francis I., in the period of Elizabeth and the Stuarts, and in the decadence of the seventeenth century. In fact, its various phases present a grotesque medley of styles, fashions, and epochs. Construction has become the art of successful deception. Is the nineteenth century destined then to close without possessing an architecture of its own? Will this age, which is so fertile in discoveries, and which displays such an energetic vitality, transmit to posterity only imitations or hybrid works without character, and which it is impossible to class?

The disease from which architecture is suffering dates from the Renaissance period, increasing from the sixteenth century to our own time, from the time when after a very superficial study of the architecture of ancient Rome—certain of whose externals were made objects of imitation—our architects ceased to make the alliance of the form with the requirements of the means of construction their chief consideration. The Greeks, later Romans, and Goths, erected public buildings whose forms were absolutely the expression of the means of construction adopted by them and which derive their beauty from that frank sincerity of expression. The Gothic architects go still further, they discard the concrete architecture of the Romans, and evolve an architecture in which all the appliances for strength are apparent, and where every element in the construction originates a form; they adopt the principle of active resistance, introduce equilibrium into the structure and in fact are impelled by the genius of modern times, desiring a distinct function for each product. This should be followed up, and not the reproduction of architectural forms belonging to another

civilisation in materials that are unsuitable.

Roger Bacon, that worthy monk and rival of the artists of the thirteenth century, in his "Compendium Philosophiæ," chapter i., insists that the youngest are in reality the oldest, and that recent generations ought to surpass their predecessors in intelligence, since they inherit all the labour of the past; and further, in his "Opus Tertium," he insists that "experimental science is the queen of the sciences and the goal of all speculation." These were principles which were acted upon in his time, the thirteenth century, for it was by means of method, examination, and experiment that thirteenth-century





Gothic was evolved from the tradition of Romanesque art.

In architecture, materials must indicate their functions by the form we give them, and these should conform to their nature. This, of course, has been more or less easy for past styles, working in natural materials having no very great contrasting qualities, but it is very difficult for us who have to make use of materials which possess different and even opposite qualities, to which must be given the appearance befitting these opposite qualities.

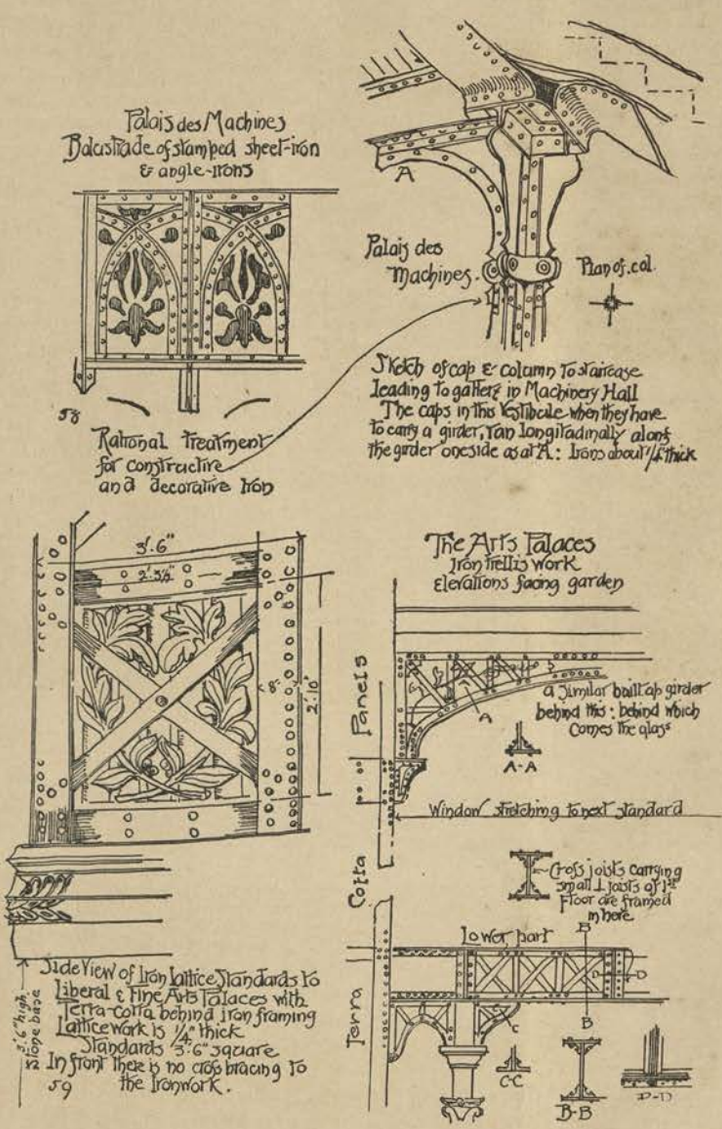
What are these materials? Firstly, *iron*, cast and wrought, and *steel*. It can hardly be doubted that if the Romans had had at their command cast and wrought-iron girders of large dimensions, they would have used them, as also the Gothic architects, for as Viollet-le-Duc has pointed out, they did their best to find a substitute for them by using very tough stone placed on end, when heavy masses had to be erected on light supports. The mediæval principles of elasticity and of equilibrium might well be adapted to a material which lends itself as a means of bracing oblique thrusts. But have we not used iron in a manner worthy of its nature and capabilities? Assuredly yes. This leads us to a definite statement with which we think most will agree, although seemingly a paradox—that the true architecture of the nineteenth century is engineering. By seizing upon the capabilities of these materials, iron and steel, engineers have produced works which will go down to posterity as the essential product of the nineteenth century; works in which all the qualities of the new material have been well expressed. Take our iron bridges, suspension and cantilever, the Brooklyn Bridge with its sheer span of 1,600 ft., and the Forth Bridge with its cantilever trusses of 1,700 ft. span, both the best examples of their type, and we are at once struck with the skill and ingenuity of their structure, which is fully expressive of the scientific and material progress of our age. Take next our great roofs of iron and steel, our roof at St. Pancras and Olympia, and other great railway termini, and we see how constructively we are progressing. The Crystal Palace is, however, essentially a transition building of the last generation; never likely to be repeated except by the emasculated taste of some twentieth century archæologist, because it is not based on a scientific knowledge of the material.

At the Paris Exhibition, buildings were erected of a framework of steel and iron, which astonished by their novelty of treatment. The "Galerie des Machines," with its clear span of 375 ft. and height of 141 ft., is a masterpiece of construction worthy to rank with the most daring of Roman and Gothic constructions. Would it have been possible to have erected such without the stimulating force of new material? Certainly not. It is encouraging that the general outline and design of detail was prepared in this case by an architect, and that the whole, being composed of ordinary sections of steel, placed together in an artistic manner, has given a building which is as characteristic of the material in which it is built as is a building in stone, brick, wood, terra-cotta, or any other material.

Other buildings at the Paris Exhibition are given; and, in most of these, the junction of iron framing with glazed tile or terra-cotta filling was admirably carried out, and well suited to the environment of large modern towns in which coloured glazed surfaces are at once decorative and economical, and lend a warmth and cheerfulness of aspect where

smoke and acids so soon deface the more usual building materials. The roofs and structures at the Chicago Exhibition carried the design of steel work still further in the direction of lightening the scantlings and of giving the material that lace-like character which seems its ultimate goal.

The subject can hardly be left without mentioning the steel frame structures of Chicago. But, in doing so, the objects of these structures cannot be gone into, except so far as saying that they entirely answer the programme or requirements and the engineers to take the van. Architecture at the present day is really in very much the same position that Roman architecture occupied at the beginning of the Empire, in which the old Greek columnar treatment was used in many buildings as a facing to the real construction behind, while other structures such as baths, domes, vaults, &c., were developing the new material, concrete, in the construction of enormous structures devoted to new purposes. Nowadays, we have a similar mixed architecture, only gathered from many styles instead of one, running


Palais des Machines
Balustrade of stamped sheet-iron & angle-irons
58
Rational treatment for constructive and decorative iron
A
Palais des Machines.
Plan of col.
Sketch of cap & column to staircase leading to gallery in Machinery Hall
The caps in this Vestibule when they have to carry a girder, run longitudinally along the girder one side as at A: Irons about ½" thick
3'.6"
2'.3½"
2'.0"
Side View of Iron Lattice Standards to Liberal & Fine Arts Palaces with Terra-cotta behind Iron framing
Lattice work is ¼" thick
Standards 3'.6" square
In front there is no cross bracing to the Ironwork.
59
The Arts Palaces
Iron trellis work
Elevations facing garden
Panels
a similar built cap girder behind this: behind which comes the glass
A-A
Window stretching to next standard
Cross joists carrying small I joists of 1st Floor are framed in here
Lower part
Terra Cotta
B
C
C-C
B-B
D-D

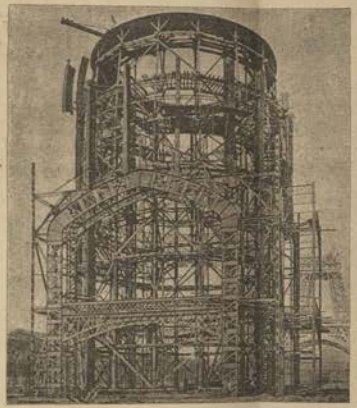
Sketches of Ironwork from Paris Exhibition.

material means of execution. The steel skeleton is entirely independent of the envelope or clothing of stonework, which simply forms a protection from the outer air; and the result is a perfectly legitimate construction, and, in fact, follows the principles laid down by Roman builders. A view of the Opera House at Chicago is given (see lithograph), in which almost a Greek severity of line is obtained.

Modern architecture has progressed and is progressing, only we are allowing our concurrently with utilitarian works, such as bridges, roofs, high buildings, exhibition structures, in which our new building material is not concrete but steel, and which will eventually stamp the period as one of steel.

Finally, the architect and engineer being separated, and the former, therefore, not having the scientific knowledge proper to his calling, inclines towards methods in previous use, and, in cases of doubt, prefers to err on the side of excess of strength, and hide his

Central Dome, Paris Exhibition (steel framework, with terra-cotta, faience, and papier-maché filling).

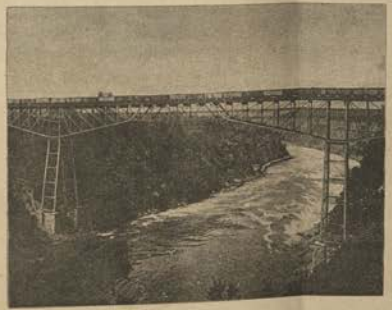


Steel framework: Paris Exhibition Buildings.

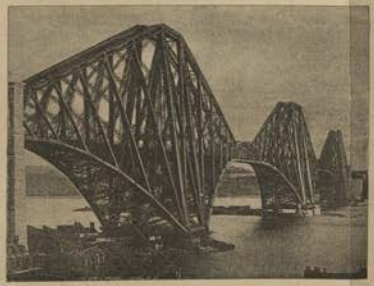
Schiller Opera House, Chicago.

A Shop Front, Paris (subsidiary employment of iron).

Brooklyn Bridge (rational application of steel to building).



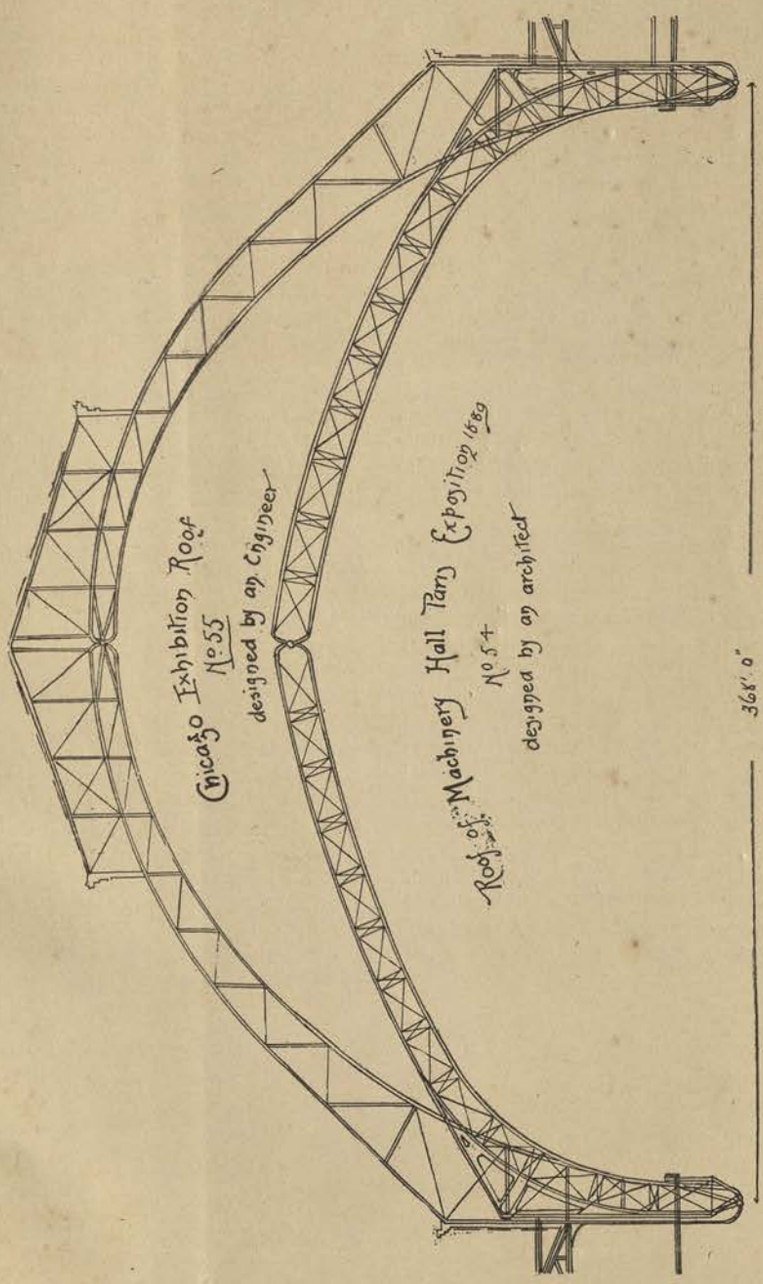
Cantilever Bridge.



Forth Bridge: the Cantilever on a great scale.

Iron Framing and Terra-cotta (Paris Exhibition Buildings.)

inexperience behind what he deems rules of art, but which are often only those of routine. Architecture, divorced from its true motive power, now known as engineering, but which in all previous periods has been a part of it, ceases to aim at anything more than the production of forms more and more losing their significance, because they are not renewing their vitality by being referred to the true principles of construction, and if they are not soon quick to see their position, architects themselves will be reduced to the condition of mere decorative designers.



CONCLUSION.

THEORY SHOWN TO HOLD IN THE MAIN, AND LESSONS DEDUCED FOR THE FUTURE.

MY thesis has been the influence of material on architecture, and in endeavouring to prove my position, I do not think I have stepped beyond the limits of a fair treatment of the subject.

The position has been that architecture is an affair of material, the true use of which moulds the style, which is created out of the qualities of the materials that have to be employed. Most assuredly from our previous study we shall admit that a form which was the expression of a necessity, were it even a commonplace one, acquired from this very circumstance a special charm.

The various materials we use possess certain qualities or properties, and if we succeed in expressing these by the form we give to our materials, not only do we take advantage of their infinite resources and open up a vast field for variety in design, but we also extend the boundaries of artistic expression by this constant endeavour to give to every object the form that befits its nature.

Certainly, in the present day, the determination to be perfectly sincere would produce novel and fascinating results, as for instance in the use of a visible iron skeleton along with a glazed faience filling in our street fronts. We should at the same time be making ourselves really classic in the sense of following out the methods pursued in the good periods of our art. Having at our disposal novel materials, mechanical appliances far more developed and complicated than those of any previous period, and possessing a thorough acquaintance with all that has been effected in the past, we need but this determination to be sincere in order to excel. We have only to comply absolutely with the requirements of each case, taking the available materials for what they are worth—that is, for what may be attempted consistently with their special properties—then making some little use of science and a good deal of our reason, we should be able to lay the foundations of an architecture worthy of our age.

If we are to follow the principle of the past, an architect should be a scientific constructor, not necessarily working by formulæ, but one perfectly conversant with materials in their practical application. The divorce of engineering from architecture has resulted in the production of structures whose sole merit is that of economy. It is true that some of these, perhaps in part owing to their size, as the Forth Bridge and Eiffel Tower are works of grandeur, perfectly emblematic of the spirit of the age, and expressive of that spirit. Still, if their designers had been men trained to refinement of eye, and to a sense of both delicacy and strength in contour, as well as to expertness in constructive science, would they not have been more beautiful?

I show drawings of two steel roofs, the largest of modern times, the one designed by an engineer, the other by an architect. Is there not sufficient ground, even from this example, for asserting that a training of the eye to beauty of form is advantageous and necessary?

Finally, in the study of the past, we should observe a clear distinction between a form which is only the reflection of a tradition, and a form which is the immediate expression of a requirement, constructively met; for it is only the study of the latter that issues in practical advantage—an advantage not consisting in the imitation of a form, but in the example it affords of the application of a principle.

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